ALLOCATION OF COMMUNICATION RESOURCES

[0001] This disclosure relates to allocation of resources for communications and more particularly but not explicitly to allocation of resources for uplink control signals for wireless communications.

[0002] A communication system can be seen as a facility that enables communication sessions between two or more nodes such as fixed or mobile devices, machine-type terminals, access nodes such as base stations, servers and so on. A communication system and compatible communicating entities typically operate in accordance with a given standard or specification which sets out what the various entities associated with the system are permitted to do and how that should be achieved. For example, the standards, specifications and related protocols can define the manner how devices shall communicate, how various aspects of communications shall be implemented and how devices for use in the system shall be configured.

[0003] Users can access the communication system by means of appropriate communication devices. A communication device of a user is often referred to as user equipment (UE) or terminal. A communication device is provided with an appropriate signal receiving and transmitting arrangement for enabling communications with other parties. Typically a device such as user equipment is used for enabling receiving and transmission of communications such as speech and content data.

[0004] Communications can be carried on wireless carriers. Examples of wireless systems include public land mobile networks (PLMN) such as cellular networks, satellite based communication systems and different wireless local networks, for example wireless local area networks (WLAN). In wireless systems a communication device provides a transceiver station that can communicate with another communication device such as e.g. a base station of an access network and/or other user equipment. The two directions of communications between a base station and communication devices of users have been conventionally referred to as downlink and uplink. Downlink (DL) can be understood as the direction from the base station and uplink (UL) the direction to the base station.

[0005] Various control information may need to be signalled between the parties. Control information is typically communicated on control channels, for example on physical uplink control channel (PUCCH) or physical downlink control channel (PDCCH). For example, information relating to resource may need to be signalled between stations. Allocation of resources for the downlink and the uplink can be handled independently. Uplink (UL) assignments or grants sent to a user equipment (UE) are used to inform the user equipment of resources the UE shall use to transmit data. Information when anything might be expected in the downlink may also be communicated from a base station. By means of the grants dynamic allocation of resources can be provided. Signalling of other types of control information is also needed. For example, a user equipment may need to signal feedback information on the uplink. Feedback information can be provided for the purposes of error detection and/or correction. Requests for retransmission of any information that the recipient node did not successfully receive are possible. For example, hybrid automatic repeat request (HARQ) error control mechanism may be used for this purpose. The error control mechanism can be implemented such that a transmitting device shall receive either a positive or a negative acknowledgement (ACK/NACK; A/N) or other indication regarding its transmission from a receiving device.

[0006] Increased utilization of advanced systems for various scenarios and different data traffic types increases the need to optimize the system further for a large number of users. A way to achieve this is to improve scheduling efficiency. In particular, reduction in scheduling overhead may be desired. It might be desired in certain applications to reduce downlink control signalling overhead caused by uplink and downlink scheduling. Optimization of signalling on physical downlink control channel (PDCCH) could be of particular advantage. For example, currently PUCCH resource allocation for PDSCH ACK/NACK is based on implicit mapping where the index of the lowest PDCCH Control Channel Element (CCE) determines directly the index of the PUCCH resource. Such "one-to-one" mapping provides a relatively efficient resource allocation scheme for a number of active UEs as dedicated ACK/NACK channels are not needed for each of them. Instead, the channels can share a common resource space which has the same size as the number of downlink CCEs. However, increased multiplexing of different users increases the number of possible downlink control channels. On particular, if different technologies, for example code division multiplexing (CDM) and frequency division multiplexing (FDM) are used, the number of possible downlink control channel candidates increases. This may be particularly the case with enhanced physical downlink control channels (ePDCCH). Furthermore, techniques such as multi-user multiple input multiple output (MU-MIMO) scheduling may be enabled for ePDCCH, and this in turn may increase the number of possible ePDCCH candidates in a cell, possibly up to several hundreds. In such situation one-to-one indexing of all the possible ePDCCH candidates could easily lead to an excessive number of ACK/NACK channels, and hence uplink overhead. Therefore there is a need for a more efficient indexing system for uplink control resource allocation, for example for PUCCH ACK/NACK resource allocation in case of ePDCCH scheduling such that collisions can be avoided.

[0007] It is noted that the above discussed issues are not limited to any particular communication environment and station apparatus, but may occur in any appropriate station apparatus where internal communications are required.

[0008] Embodiments of the invention aim to address one or several of the above issues.

[0009] In accordance with an embodiment there is provided an apparatus for allocation of resources for wireless communications, the apparatus comprising at least one processor, and at least one memory including computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to determine an index for a uplink control resource in accordance with a predefined rule, the determining taking into account an index associated with a physical downlink resource and the amount of downlink resources to be mapped on the uplink control resource.

[0010] According to another aspect, there is provided a method for allocation of resources for wireless communications, the method comprising determining an index for a uplink control resource in accordance with a predefined rule, the determining taking into account an index associated with